Cuscuta campestris

Parasitism of *Bolboschoenus fluviatilis*

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agresearch
āta mātai, mātai whetū

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Te Papa Atawhai

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Executive Summary

- *Cuscuta campestris* is an Unwanted Organism in New Zealand (NZ) but is present in 5 known wild populations in the Waikato which includes our nationally significant high conservation Whangamarino wetland.

- The overall objective of this research project is to determine the range and threat by the parasitic plant, *Cuscuta campestris* to NZ ecosystems through glasshouse and laboratory investigations.

- A previous report (AgResearch Report #12167) determined *C. campestris* could not readily establish from seed on mature *Bolboschoenus fluviatilis* plants. However, in the field *C. campestris* has been observed by Department of Conservation Te Papa Atawhai (DOC) staff coiled around mature *B. fluviatilis* plants. Its degree of impact to this important wetland native species is unknown.

- This report is a first milestone in investigating *C. campestris* host plants and specifically reviews whether *C. campestris* can host on *B. fluviatilis,* if already established on an alternative nearby host plant.

- An investigation was carried out by AgResearch at the Ruakura, Hamilton, containment glasshouse facility which determined *C. campestris* did not readily parasitise *B. fluviatilis* (not a major host), but it did adhere (chemical adhesion) to the younger green *B. fluviatilis* stems for physical support. Parasitism by *C. campestris,* haustoria[1] present in the epidermis*,* was observed just once despite the physical contact to *B. fluviatilis*. This one parasitism event was however, deemed 'unsuccessful' as *C. campestris* died off and did not thrive like it did with other known plant hosts.

- In conclusion, from this investigation, the susceptibility of *B. fluviatilis* as a host to *C. campestris* is low. Sustaining populations of *C. campestris* at known Waikato sites appears to be supported by other alternative host plant species. Control of the identified *C. campestris* hosts (refer Table 1) around *B. fluviatilis* would therefore help control *C. campestris* infestations and its impact on *B. fluviatilis*, an important wetland native species.

- Further investigations and reporting of host species, including whether *C. campestris* can establish on newly emerged (soft) *B. fluviatilis* shoots, agriculturally significant hosts such as clover and ryegrass and Rongoā plant hosts will be included in the second milestone and final report due May 2024.

[1] A root like structure that grows into and around another structure to absorb water and nutrients. Haustoria appear as swollen tissue at a contact point between parasite and host. Specifically, for *Cuscuta* spp. haustoria resemble suction cups connecting the host and parasite.

1. Background

1.1 Background

Cuscuta campestris is an annual parasitic plant. It has a wide distribution across temperate, sub-tropical and tropical regions of the world, and is a known weed of 25 crops in 55 countries. It is an Unwanted Organism in New Zealand (NZ) but is present in 5 wild populations in the Waikato (including national significance high conservation areas, like Whangamarino wetland) and is listed as a Progressive Containment plant on the Waikato Regional Council Regional Pest Management Plan 2021-2031. As a pest plant it has the potential for further entry into NZ through contaminated seed lots due to its prolific seed production, overseas host range and its visual similarity to clover seed, a common agricultural seed import into NZ.

Its host range on NZ natives is largely unknown. Host preference, referring to the choice of the most desirable host for optimal growth, is also unknown in NZ. Host preference identification helps with identifying future sustaining populations of *Cuscuta* species. Weed management and progressive containment is aided by both the knowledge of both *Cuscuta campestris*'s host range and host preference. Host range knowledge will also elucidate the threat to known high value NZ ecosystems and culturally significant native plants.

1.2 Previous reports

The AgResearch report (#12167), ***Cuscuta campestris* seedbank evaluation from Lake Whangape and Whangamarino Wetland, Waikato region, NZ**. (June 2022) identified *C. campestris* host plants replicated in Table one. All these plants are present at the Department of Conservation Te Papa Atawhai (DOC) managed Waikato wetland sites where *C. campestris* wild populations have been identified.

***Table one: Host plants of* Cuscuta campestris *identified in 2022*[2].**

Exotic weed hosts	Native hosts	Exotic Grasses/sedges host	Agricultural weed host
Alternanthera philoxeroides (alligator weed)	*Persicaria decipiens* (swamp willow weed)	*Cyperus eragrostis* (umbrella sedge)	**Not tested*
Bidens frondosa (beggars' tick)	*Solanum americanum* (small-flowered nightshade)		
Lotus pedunculatus (lotus)			
Ludwigia peploides (primrose willow)			
Symphyotrichum subulatum (sea aster)			

B. fluviatilis was specifically investigated as DOC field staff had previously observed it supporting *C. campestris* and there was a desire to confirm if parasitism was occurring and establish some of the impacts *C. campestris* posed to this important wetland native. As a wetland plant *B. fluviatilis* helps to stabilise the margins of wetlands and is an important habitat plant for the nationally endangered Matuku or Australasian bittern. Matuku are critically threatened with fewer than 1000 birds nationally and are important to Māori, appearing in their legends and their feathers used for ceremonial decorations.

The 2022 report established the native *B. fluviatilis* could not be parasitised by *C. campestris* as an emerging seedling from seed. It failed to attach from the ground. The sheath at the base of *B. fluviatilis* providing a physical barrier to parasitism from newly emerged *C. campestris* seedlings. The question was therefore posed:

"Could *B. fluviatilis* be parasitised by *C. campestris* if *C. campestris* was already established on a nearby host plant?"

This report outlines our findings to this question and defines parasitism by *C. campestris* where *C. campestris* has developed haustoria and has been identified under a compound microscope as penetrating the epidermis of its host plant.

Successful parasitism of a host plant is defined where this is identified, and the parasitic plant is observationally seen as growing and developing on its host to complete its lifecycle.

[2] Identified hosts only. Classification and preference host testing was no carried out in 2022/23 but will be investigated in this project's second milestone.

2. Method

B. fluviatilis plants and soil were provided by DOC and potted into 20 cm^2 square tubs of Daltons potting mix. Additionally, known host plants, identified from Table one were also planted into 20 cm^2 square tubs of Daltons potting mix. All plants were kept at AgResearch Ruakura PC1 containment glasshouse facility in agreement with Ministry of Primary Industries, Manatu Ahū Matua (MPI) permissions granted[3]. This glasshouse maintains an average daytime temperature of 24°C throughout the year.

C. campestris seed (collected from earlier studies <9 months old) was scarified using P180 sandpaper (Zaroug, Mohamed Saeed Ahmed, 1989). Thirty scarified seeds were evenly scattered on the soil around established known plant hosts (identified in Table 1). Seeds were very lightly covered in seed raising mix and watered regularly to promote germination. Germinated *C. campestris* seedlings were left over several months to establish on these known alternative plant hosts which are present at known *C. campestris* Waikato sites.

C. campestris plants were well established, after about 3 months, and actively growing and coiling around hosts. Both young (but not seedlings) and mature *B. fluviatilis* plants were placed beside potted *C. campestris* plants already parasitising a known host plant. Plants were left another 3 months to determine susceptibility of *B. fluviatilis* to *C. campestris* if already established on alternative hosts.

Optical and microscopic observations and dissection of *C. campestris* on mature and young *B. fluviatilis* were used to determine parasitism. Parasitism in this report, as defined earlier, is where *C. campestris* has developed haustoria and has been identified under a compound microscope as penetrating the epidermis of its host plant. However, successful parasitism of a host plant is defined where this is identified, and the parasitic plant is observationally seen as growing and developing on its host. Specifically, if wilting and death of regions of *C. campestris* occurs after parasitism by haustoria, then *C. campestris* is unable to extract sufficient nutrients from its host to complete its lifecycle and successful parasitism did not occur.

The investigation, over 6 months, was completed once *C. campestris* had flowered and set seed on other known host plants.

3. Results and Discussion

3.1 Adhesion and parasitism of *B. fluviatilis*

In this study *C. campestris* was observed adhering to young green *B. fluviatilis* plants but not to the lower parts of the mature *B. fluviatilis*. The brown fibrous sheath at the base of the mature life stage physically prevented adhesion.

[3] Note: As *C. campestris* is an unwanted organism in NZ, MPI permissions were required and obtained before research could begin. AgResearch holds this permission for research purposes till February 2028.

On young green *B. fluviatilis* plants *C. campestris* attached four times (at times quite firmly) over the investigation period despite the unrestricted opportunity for parasitism with *B. fluviatilis*. Viewing these attachments under a compound microscope and via dissection showed only one incidence however, where *C. campestris* haustoria had penetrated the cell wall of a young green *B. fluviatilis* shoot. This one case where parasitism by *C. campestris* was achieved could not be considered 'successful' as the parasitic plant region attached to *B. fluviatilis* turned pale (from bright orange yellow to pale yellow), failed to thrive, and died following parasitism. See Figures 1 and 2.

C. campestris did flower and produce seed while adhered to young green *B. fluviatilis* however, this was most likely due to a reallocation of resources from nearby established more susceptible parasitised host plants.

C. campestris parasitism of young green *B. fluviatilis* plants in this single case highlights the different degrees of host plants susceptibility and preference. Further investigation of *C. campestris* hosts in this project's next milestone will include a scoring system to better demonstrate the degree of host susceptibility and preference by *C. campestris* on separate hosts.

In conclusion *C. campestris* can adhere and parasitise the young green stems of *B. fluviatilis* however it does not readily do so, finding it difficult to parasitise the native unless supported by alternative more susceptible nearby host species. It is likely if alternative hosts were absent *C. campestris* would struggle to survive on *B. fluviatilis* alone as it fails to establish from seed as a seedling on established mature *B. fluviatilis* and struggles to readily infect the younger green fleshier *B. fluviatilis* stems. Control of the above identified *C. campestris* hosts (refer Table 1) around *B. fluviatilis* would therefore help control *C. campestris* infestations and its impact on *B. fluviatilis*, an important wetland native species.

3.2 Additional host

Broad-leaved fleabane, *Conyza sumatrensis,* was identified as successfully parasitised (Haustoria penetrated and *C. campestris* completed its lifecycle on this host) by *C. campestris* during this investigation (refer Figure 7). This host was not previously reported in the earlier June 2022 report.

Figure 1 and 2: C. campestris *coiled around* B. fluviatilis*. Coiling, adhesion and then flowering occurred but parasitism through the cell wall was only identified on one occasion (red arrow) demonstrating parasitism susceptibility of* B. fluviatilis *by* C. campestris *is poor but not impossible.*

Figure 3: C. campestris *growing on* B. fluviatilis *leaf blade and haustoria present (shown by red circle) but did not penetrated cell wall.*

Figure 4: *A dying stem of* B. fluviatilis *with adhered* C. campestris*. Flowers of* C. cuscuta *died before seed pod development.*

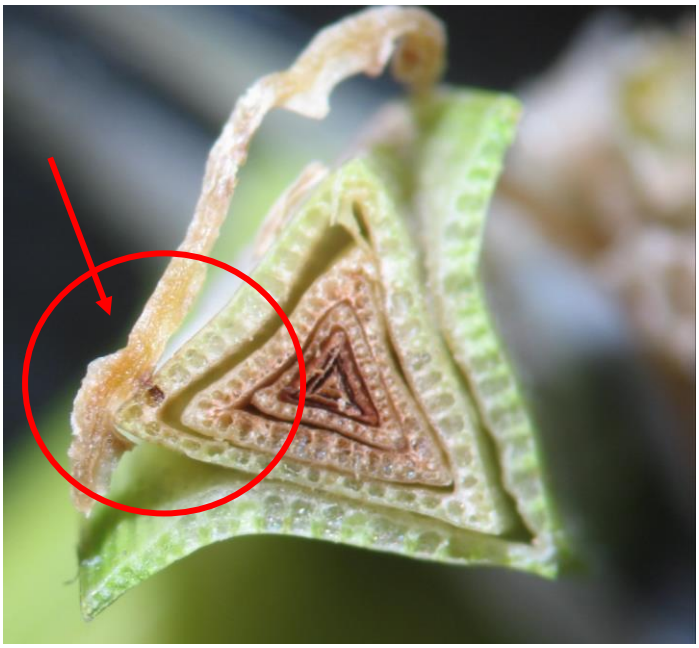

Figure 5: *Penetration of* B. fluviatilis *by* C. campestris *haustoria achieved on young* B. fluviatilis *stems but* C. campestris *was unable to successfully thrive on* B. fluviatilis*, withering and dying post parasitism while at the same time remaining healthy on other adjacent hosts. The brown centre of* B. fluviatilis *seen is not considered related to* C. campestris*.*

Figure 6: *Parasitism of* C. campestris *on* Conyza sumatrensis *(broad-leaved fleabane). New weed host not previously noted in 2022 report.*

4. References

Hackell, D. and James, Trevor. 2022. *Cuscuta campestris* seedbank evaluation from Lake Whangape and Whangamarino Wetland, Waikato Region, NZ. Client report for the Department of Conservation. Report number 12167.

Waikato Regional Pest Management Plan 2022-2032, Tūtohu mahere whakahaere ā-roheo waikato mō ngā kírearea. https://www.waikatoregion.govt.nz/assets/WRC/WRC-2019/RPMP/RPMP-2022.pdf

Zaroug, Mohamed Saeed Ahmed. (1989). Ecological Studies on Dodder (*Cuscuta japonica* Choisy) in Hokkaido: Seed Germination and Host-Dodder Relationship. Environmental Science. 12 (1), 63-119.

5. Acknowledgements

This research was funded in partnership with the DOC and part of a first milestone due 30 June 2023. A more comprehensive report will be prepared as part of the second milestone by May 2024. This May 2024 report will establish a host scoring system, and report on further host testing from a priority list and host plant attributes contributing to successful parasitism by *C. campestris*. Risks to Rongoā will also be considered.

C. campestris is an Unwanted Organism in New Zealand (NZ). Permission to conduct this research was made possible after a granted application from the MPI under the Biosecurity Act 1993 sections 52 and 53 and due to the containment facilities available at AgResearch - Ruakura.

In addition to this report, a conference presentation was delivered at the 2022 Plant Protection Society Conference in Christchurch to promote awareness of *C. campestris* present at some Waikato sites in NZ and acknowledge the collaboration and research being undertaken between AgResearch and DOC in learning more about this Unwanted Organism within a NZ context. The reference to this conference proceeding is below:

Hackell, D, James, T and Bodmin, K. 2022. Conference presentation: Golden dodder (Cuscuta campestris) seed longevity and plant hosts in wetland environments. https://nzpps.org/wp-content/uploads/2022/09/NZPPS-22-conference-programme-and-abstracts-FINAL-110922.pdf